



Cost and FTE

- The Colorado Geological Survey at the Colorado School of Mines requests \$105,494 General Fund and 1.0 FTE to improve assistance to local governments and agencies on geologic hazard maps, providing post-disaster response and recovery technical assistance and the provision of hazard planning technical assistance. The Colorado Geological Survey has the responsibility of creating and disseminating geologic hazard information about Colorado to its citizens, schools, private sector, and government.

Current Program

- One of the key statutory missions of CGS is to assess the vulnerability of people, state assets, and property to natural hazards and to help reduce those risks.

Problem or Opportunity

- Approximately \$28M of state assets are vulnerable to landslide, \$18.9M of assets in Colorado are vulnerable to rock fall, \$87.4M of state assets are at risk from potentially unstable soil, and \$2.3 billion of state assets are vulnerable to debris flow. In recent years, CGS disaster response and recovery work has taken over 2,000 hours a year.

Consequences of Problem

- There has been a sharp decrease in Colorado Geological Survey at Mines geologic hazard mapping and associated technical support to state and local agencies. Local officials cannot protect the built environment, physical infrastructure, the natural environment, and the quality of life in their communities unless they can adequately assess vulnerabilities to geologic hazards.
- The ability of the Colorado Geological Survey - Mines to respond to geological hazards and assist local governments could be limited to respond to emergencies. The agency cannot meet its basic statutory requirements for its customers in an optimal way with the current level of staffing/funding given recent disasters.

Proposed Solution

- This request will help correct the significant decrease in geologic hazard mapping. The additional funding and FTE will allow the Colorado Geological Survey at Mines to create new hazard maps and provide needed technical support to the state and local communities in order to reduce the occurrence of hazards or limit exposure to hazards.



COLORADO

Department of Higher Education

John W. Hickenlooper
Governor

Lt. Governor Joseph A. Garcia
Executive Director

FY 2015-16 Funding Request | November 1, 2014

Department Priority: R-4

**Request Detail: Geologic Hazard Mitigation FTE – Colorado Geological Survey,
Colorado School of Mines**

Summary of Incremental Funding Change for FY 2015-16	Total Funds	General Fund
Geologic Hazard Mitigation FTE	\$105,494	\$105,494

The Colorado Geological Survey (CGS) request is for \$105,494 General Fund and 1.0 FTE to improve assistance to local governments and agencies on geologic hazard maps, providing post-disaster response and recovery technical assistance and the provision of hazard planning technical assistance. The Colorado Geological Survey has the responsibility of creating and disseminating geologic hazard information about Colorado to its citizens, schools, private sector, and government.

Problem or Opportunity:

Approximately \$28M of state assets are vulnerable to landslide, \$18.9M of state assets are vulnerable to rockfall, \$87.4M of state assets are at risk from potentially unstable soil, and \$2,254.7M of state assets are vulnerable to debris flow. In recent years, CGS disaster response and recovery work has taken over 2,000 hours a year. When the Mesa County Sheriff needed the Colorado Geologic Survey to determine if it was safe for first responders to search for victims, CGS responded immediately. When Boulder County flooded in 2013, CGS staff were on the scene - but their staffing level left no other staff available for a call to the scene when the Chaffee County rockslide occurred.

The ability of the Colorado Geological Survey - Mines to respond to geological hazards and assist local governments will be stretched and potentially limited to respond to emergencies. The agency cannot meet its basic statutory requirements for its customers in an optimal way with the current level of staffing/funding given recent disasters.

One of the key statutory missions of CGS is to assess the vulnerability of people, state assets, and property to natural hazards and to help reduce those risks. Colorado is a geologically diverse state with the nation's highest average elevation, wide river valleys, and rugged canyons. It has hundreds of mountains that reach elevations of 11,000 to 14,000 feet. Geologic hazards are present in every part of the state from the plains to the highest peaks. As population increases in hazard prone areas, communities are more vulnerable to loss of life and economic damages. Community resilience, or the ability of a community to withstand or mitigate the effects of a disaster, is greatly dependent on knowing vulnerabilities to hazards. Many communities in Colorado do not have the basic information needed to build community resilience: an inventory of potential geologic hazards. Figure 1A shows areas in the state that have little to no mapping of geologic hazards at a scale adequate for land use and emergency management planning. Figure 1B shows projected average annual growth rates for Colorado. There is little geologic hazard data available for many of the counties with the highest projected growth rates.

Figure 1A: Status of Planning Level Geologic Hazard Mapping

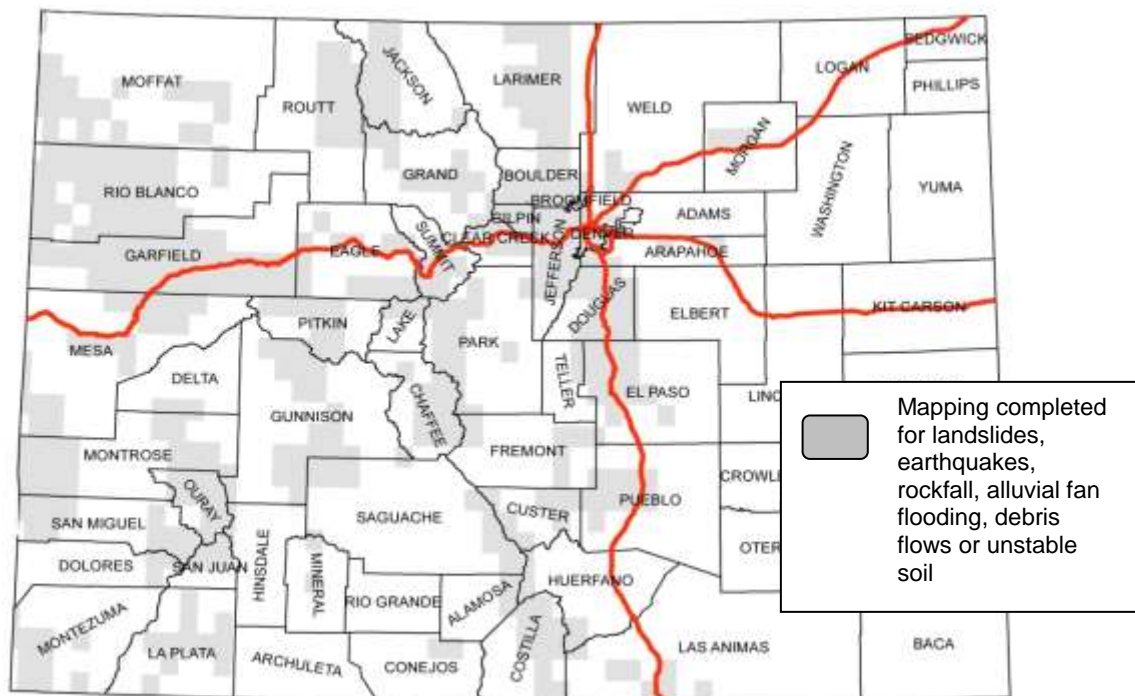
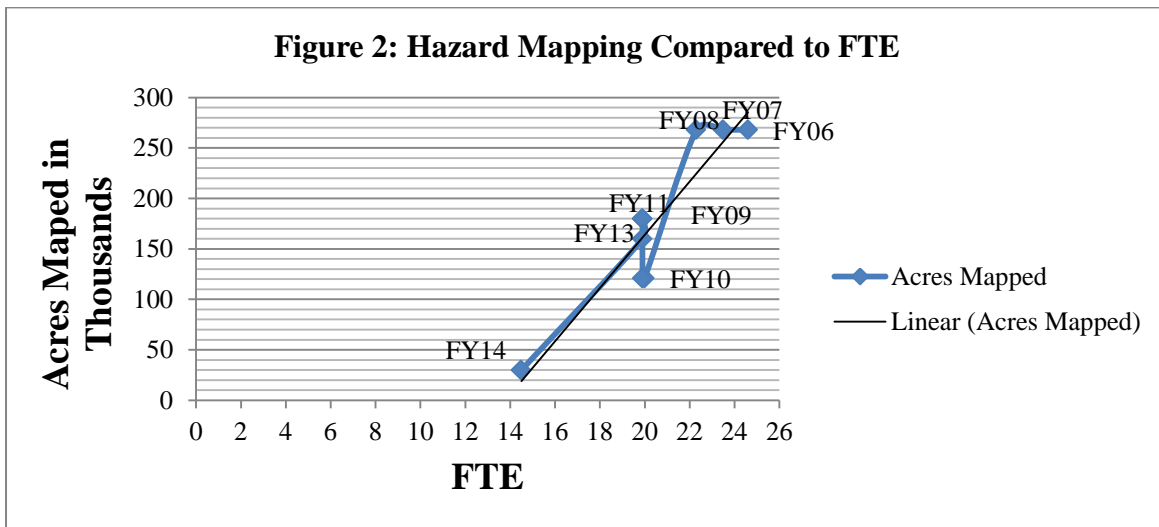


Figure 1B: Projected Growth Rates

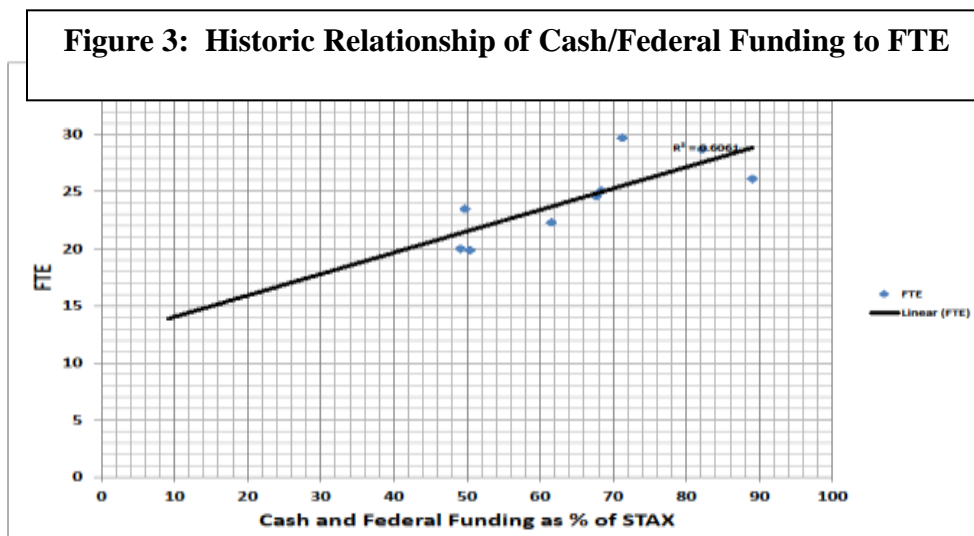


Much of the existing geologic hazard mapping was done prior to 2010 when CGS staffing levels ranged from 29.7 (FY01) to 20 FTE. Current FTE is 14.5. Staff reductions, in combination with increased response to disaster and recovery activities, has resulted in a sharp decrease in geologic hazard mapping and associated technical support to state and local agencies. For example, in FY07 actual FTE was 23.5 and CGS mapped potential geologic hazards on approximately 268,000 acres. During FY14, staffing was

reduced to 14.5 FTE and approximately 30,000 acres were mapped. Historic mapping rates compared to FTE are shown in Figure 2.



The reduction in FTE has also hampered the ability of CGS to obtain non-state funding for geologic hazard mapping and other functions. It is difficult to generate funding proposals and development relationships with potential funding partners without sufficient staff. This is demonstrated in Figure 3 that shows the relationship of cash and federal funding to FTE. For example, in FY04, actual FTE was 25.1; CGS was able to leverage every dollar in severance tax with 90 cents in cash and federal funding. Each year as FTE was reduced, the ability of CGS to leverage state funding also decreased.



This request will help correct the significant decrease in geologic hazard mapping. The additional funding and FTE will allow CGS to create new hazard maps and provide needed technical support to the state and local communities in order to reduce the occurrence of hazards or limit exposure to hazards.

Background on the Geologic Hazards Program

In Colorado, almost all land-use and building decisions are made at the local level, and few local governments have the geologic expertise to interpret geologic maps and glean from them the information they need on vulnerabilities to geologic hazards. Therefore, it is vital for CGS to provide technical support at the state and local level and produce special map products that are based on thorough geologic mapping and analysis but that focus on the critical factors that might impact public safety. CGS provides this key service in the following ways:

- CGS produces hazard maps, or derivatives of geologic maps, which only contain the geologic hazard information needed by land-use and emergency management planners and decision-makers;
- CGS provides disaster response and recovery support to state agencies and local governments;
- CGS helps state agencies and local governments create emergency management plans and comprehensive land-use plans where public and private investments are located in areas with the least exposure to geologic hazards.

Example of Geologic Hazard Map Product and Use

Between 1960 and 2008, five deaths and 10 injuries occurred in Colorado due to landslides. In 2010, nine people died and four were injured by various types of landslides and direct losses due to property damage exceeded \$9 million (COEM and USGS). In an effort to reduce such losses, CGS developed the Colorado Landslide Inventory which is a GIS-based online map available to the public.

The map is used by the Colorado Office of Emergency Management for hazard mitigation planning. The statewide hazard mitigation plan is Colorado's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage and loss of life.

Figures 4 and 5 are directly from the Colorado Natural Hazard Mitigation Plan and demonstrate how CGS maps are used to estimate potential landslide losses to state-owned and operated facilities, including all educational facilities. The state estimates that the value of assets at risk from mapped landslide hazards exceeds \$28 million and \$2.2 billion for other mapped geologic hazards.

Figure 4: Example of CGS Hazard Mapping Used by State Emergency Managers

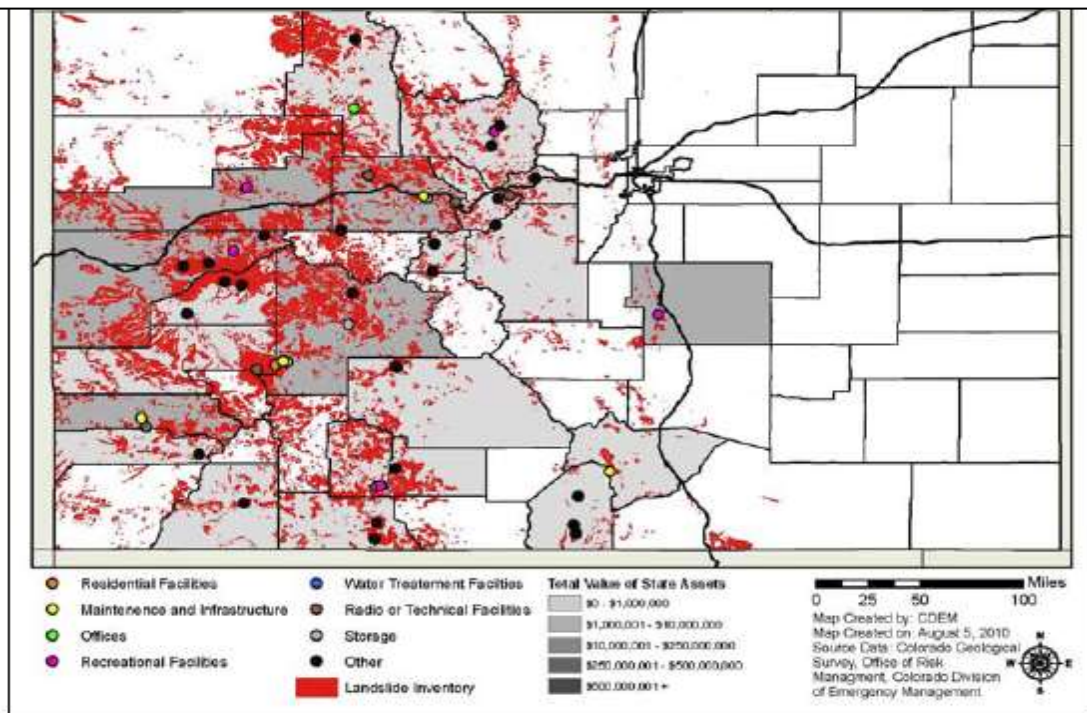


Figure 5: State Assets at Risk by Facility Type and by Type of Geologic Hazard

Facility Type	Landslide		Rockfall	
	Asset Count	Asset Value	Asset Count	Asset Value
Residences/Housing	20	\$3,593,705	3	\$1,074,127
Maintenance Facilities/ Shops/ Infrastructure	19	\$4,893,173	6	\$1,951,839
Recreational Facilities/ Rest Areas/ Restrooms	47	\$6,855,405	11	\$4,113,508
Educational Facilities/ Classrooms/ Training Rooms	0	\$0	2	\$792,398
Technology Facilities/ Radio Sites	6	\$1,499,456	8	\$2,035,085
Offices	8	\$5,458,587	8	\$4,317,297
Other	37	\$677,209	13	\$3,290,560
Water Treatment Facilities	2	\$181,204	0	\$0
Storage/ Warehouse/	23	\$5,030,284	17	\$1,340,516
Total	162	\$28,189,023	68	\$18,915,329
Facility Type	Potentially Unstable Soil		Alluvial Fan / Debris Flow	
	Asset Count	Asset Value	Asset Count	Asset Value
Residences/Housing	20	\$9,371,648	128	\$242,774,179
Maintenance Facilities/ Shops/ Infrastructure	8	\$1,488,200	53	\$30,987,099
Recreational Facilities/ Rest Areas/ Restrooms	7	\$698,972	56	\$46,596,856
Educational Facilities/ Classrooms/ Training Rooms	1	\$23,119	66	\$1,092,620,482
Technology Facilities/ Radio Sites	8	\$2,039,661	7	\$931,200
Offices	8	\$518,148	73	\$249,291,196
Other	23	\$360,172	29	\$427,329,278
Water Treatment Facilities	0	\$0	0	\$0
Storage/ Warehouse/	39	\$72,896,934	121	\$164,174,747
Total	114	\$87,396,856	533	\$2,254,705,036

Source: Colorado Geological Survey, Colorado Office of Risk Management

Efforts by CGS to Divert Staff Resources to Geologic Hazard Mapping

Disaster Response Activities

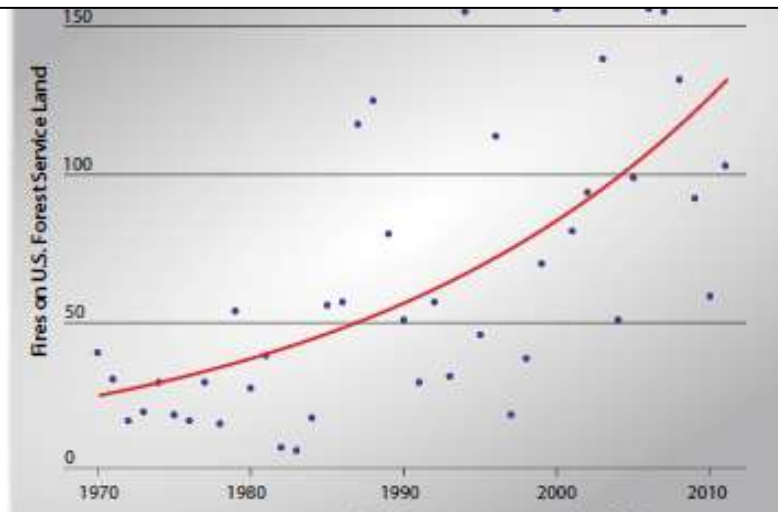
Attempts to divert staff resources to geologic hazard mapping has by hampered by the increase in demand for disaster response and recovery support. This is demonstrated in the table below. From 2006 to 2010, CGS responded to two disasters with geological hazards that included debris flows, landslides, flash flooding, rockfall, and earthquakes. Since 2010, CGS has responded to 12 disasters, including five Presidential Disasters.

Year	Declaration	Name	Response by Colorado Geological Survey
2014		Mesa County Mudslides near Collbran, Colorado	Post disaster response and recovery activities
2013	Presidential Disaster	Colorado Severe Storms, Flooding, Landslides, and Mudslides	Post disaster response and recovery activities
2013	Presidential Disaster	Colorado Black Forest Wildfire	Post disaster response and recovery activities
2013	Presidential Disaster	Colorado Royal Gorge Wildfire	Post disaster response and recovery activities
2013	FEMA Fire Management Assistance	Colorado West Fork Fire Complex	
2013	FEMA Fire Management Assistance	Colorado East Peak Fire	
2012	FEMA Fire Management Assistance	Colorado Wetmore Fire	
2012	Presidential Disaster	Colorado High Park Wildfire	Post disaster response and recovery activities
2012	Presidential Disaster	Colorado Waldo Canyon Wildfire	Post disaster response and recovery activities
2012	FEMA Fire Management Assistance	Colorado Weber Fire	
2012	FEMA Fire Management Assistance	Colorado Lower North Fork Fire	Post disaster response and recovery activities
2011	COEM Assistance	Las Animas County Earthquakes	post disaster response and recovery activities
2011	FEMA Fire Management Assistance	Colorado Duckett Fire	
2011	FEMA Fire Management Assistance	Colorado Crystal Fire	Post disaster response and recovery activities
2011	FEMA Fire Management Assistance	Colorado Indian Gulch Fire	Post disaster response and recovery activities
2010	FEMA Fire Management Assistance	Colorado Reservoir Fire	Post disaster response and recovery activities
2010	FEMA Fire Management Assistance	Colorado Four Mile Canyon Fire	Post disaster response and recovery activities
2009	FEMA Fire Management Assistance	Colorado Olde Stage Fire	
2008	FEMA Fire Management Assistance	Colorado Nash Ranch Fire	
2008	Presidential Disaster	Colorado Severe Storms and Tornadoes	Post disaster response and recovery activities related to landslides
2008	FEMA Fire Management Assistance	Colorado Ordway Fire	
2007	SBA	Prowers County (Holly) Tornadoes	
2007	FEMA Fire Management Assistance	Colorado Newcastle Fire	Post disaster response and recovery activities
2006	Presidential Emergency	Snow	
2006	Presidential Emergency	Snow	
2006	FEMA Fire Management Assistance	Colorado Red Apple Fire	
2006	FEMA Fire Management Assistance	Colorado Malo Vega Fire	
2006	FEMA Fire Management Assistance	Colorado Mauricio Canyon Fire	

As shown above, the majority of CGS disaster response is to wildfires and this trend is expected to increase. Figure 6 shows that the frequency of large fires is increasing. Since the 1970's the average number of fires over 1,000 acres each year has doubled in Colorado. More than 25 percent of Colorado's population lives in the wildland-urban interface (2014, Governor's Office Press Release)

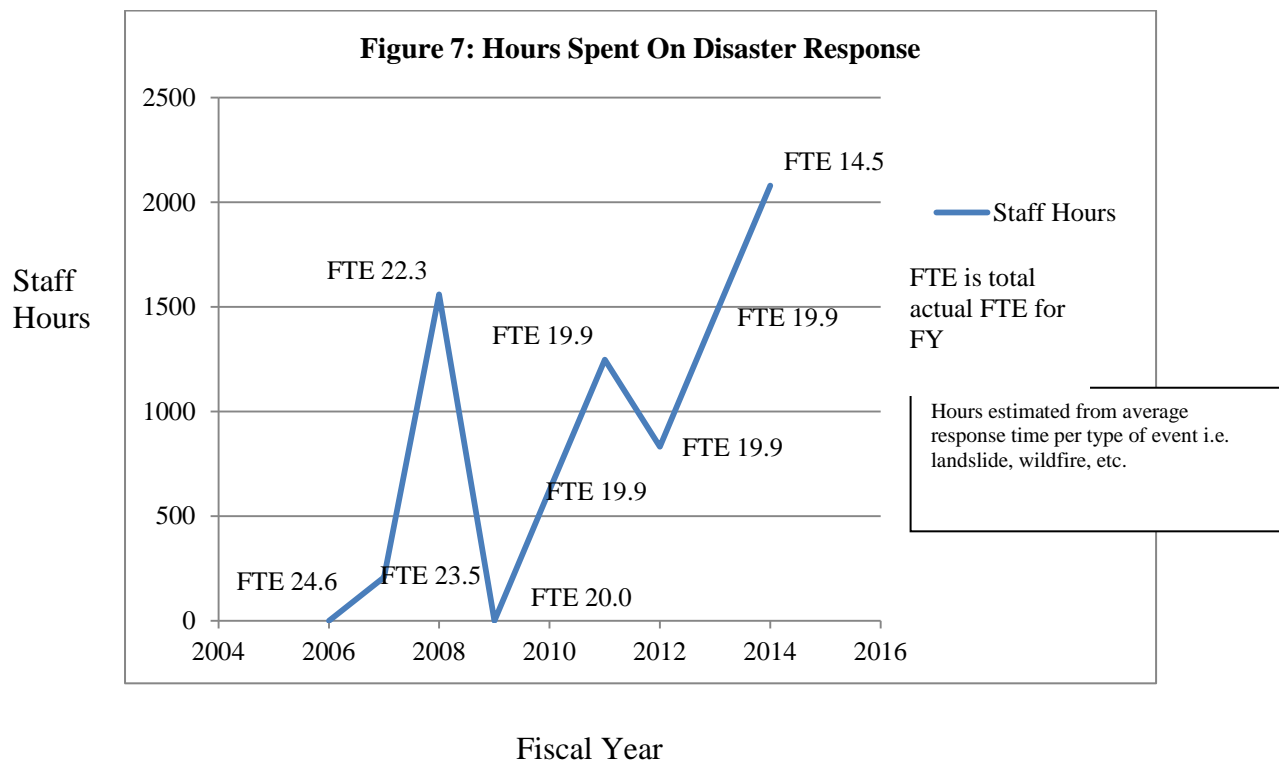
Flash flooding, landslides, debris flows and rockfall occur in the aftermath of fires. Post-fire debris flows are particularly hazardous because they can occur with little warning, block drainage ways, damage structures, and endanger human life. Wildfires, and the associated erosion, can destabilize pre-existing deep-seated landslides over long time periods. There is an increasing need for CGS to respond to disasters and help impacted communities mitigate potential landslides, debris flows and other hazards.

Figure 6: Large Fires are Becoming More Common in the West



*based on fires over 1000 acres as reported annually to the U.S. Forest Service

Figure 7 illustrates the hours spent by CGS staff on disaster response increased while total FTE decreased. This combination is one of the factors that limit the resources that can be devoted to geologic hazard mapping.

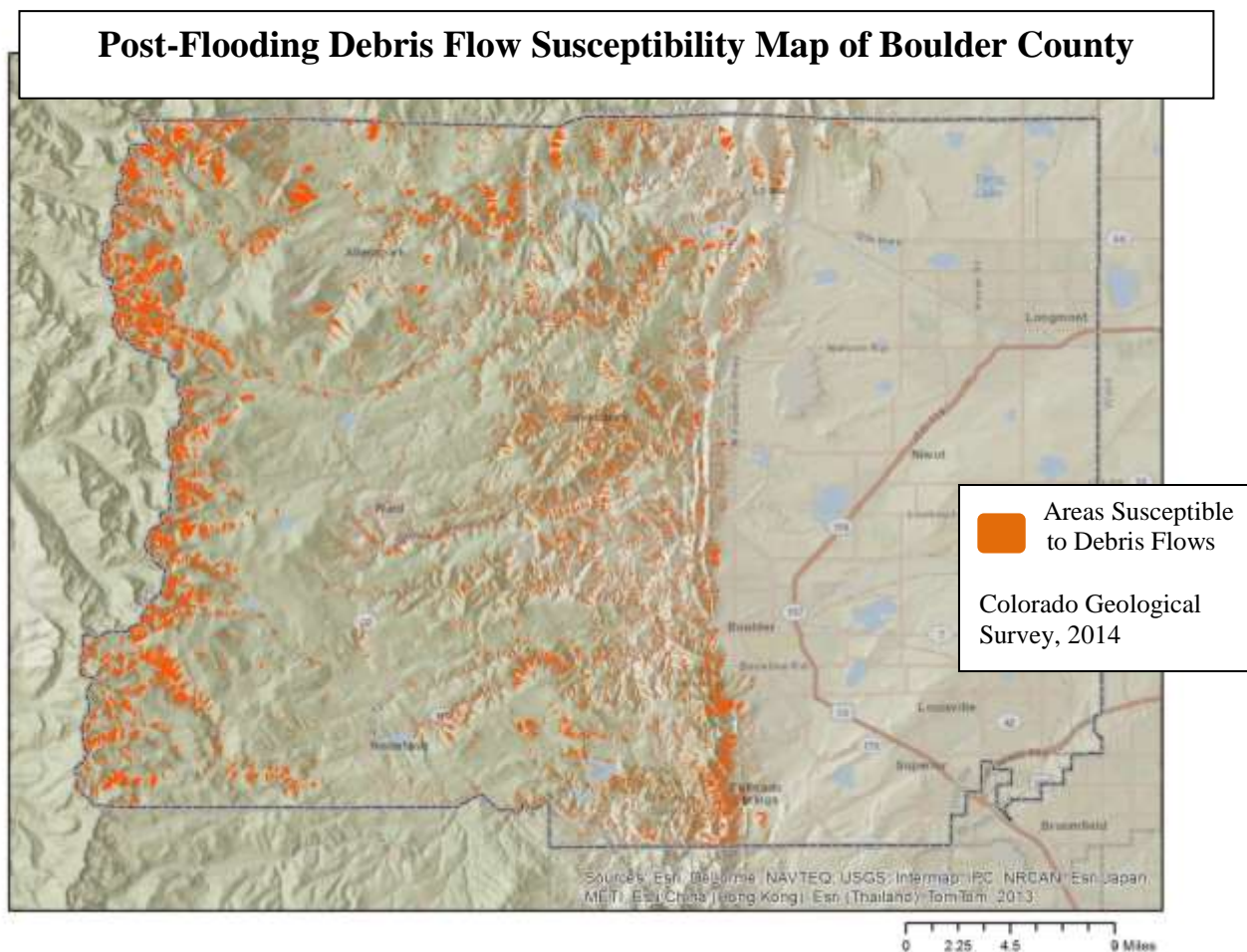


Example of CGS Emergency Response - September 2013 Flooding, Landslides, and Debris Flows

Catastrophic flooding occurred in Boulder County during the multi-day precipitation event that began on September 9, 2013. During this flooding disaster, hundreds of debris flows and landslides were triggered in Boulder County. Many of these events occurred well above and outside the mapped floodplains. Three fatalities were attributed to debris flows. One fatality occurred in Jamestown, and two occurred in the community of Pinebrook Hills west of Boulder.

Emergency response surveys done by CGS indicated that soils, fractured bedrock, and boulders on many slopes were disturbed and loosened by the rainfall. Newly built buildings, roads, and other infrastructure may be impacted by catastrophic slope failure during or following rainstorms and snowmelt for many years.

To help local communities avoid or mitigate short and long-term hazards, CGS evaluated the susceptibility of Boulder and Larimer Counties to landslides and debris flows using new mapping and modeling techniques. The last hazard mapping for the two counties was completed in 1978. CGS efforts resulted in detailed landslide and debris flow susceptibility maps that are being used by federal, state, and local recovery and land use planners. A graphic of the new Boulder County debris flow map is shown below:



Example of CGS Emergency Response – West Salt Creek Landslide

On May 25th, 2014, a very large, extremely rapid, landslide moved almost 3 miles down the West Salt Creek valley near the town of Collbran in Mesa County, Colorado. The site is on the northern flank of Grand Mesa about 38 miles east of Grand Junction. Three men working in the area were killed. CGS quickly responded to the emergency and helped Mesa County determine that the site was unstable and it was not safe to conduct immediate rescue and recovery operations.

Currently, a large, slump block remains at the top of the landslide. This block has obstructed the flow of West Salt Creek and has resulted in the formation of a lake between the slump block and the headscarp. Ongoing potential threats to downstream residents include the catastrophic failure of the remaining slump block, a rapid release of water from the lake, and rapid or slow movement of the landslide deposit.

CGS provides ongoing mapping, monitoring, and evaluation to the county on these threats.

Increased Emergency Response has Resulted in Lost Opportunities to Reduce Future Losses

Lost Opportunities to Assist with Local Planning Efforts

Land-use planning is the single most promising approach for creating disaster resilient communities. Research conducted over the past two decades suggests that, if local governments make the right choices in crafting land-use-planning programs, communities will be less likely to suffer severe losses of lives and property in natural disasters. Unfortunately, CGS finds itself in a catch-22. Responding to natural disasters has reduced the agency's ability to help local governments avoid or reduce hazard exposure.

One study looked at the relationship between state requirements for preparation of local government comprehensive plans and claims paid by property insurance companies for losses due to storm-related natural disasters between 1994 and 2000. During the period studied, insurance companies paid out more than \$26 billion for disaster-related claims arising from losses to residential property. Analyses indicate that insured losses to residential property over the period studied could have been reduced by 0.52% if all states had required local comprehensive plans and by a further 0.47% if, in addition, they had required consideration of natural hazards in local plans.

In 2013, residential property in Colorado was valued at 38.5 billion. Most of the counties with significant private and public investment in housing are also located in areas with significant geologic hazards. Building disaster resilience into land use plans will help limit losses and protect public safety.

Colorado, which ranks among the top ten states with catastrophic losses (Rocky Mountain Insurance Information Association), has 271 cities and towns and 64 counties. A total of 40 local governments have geologic hazard elements in their land use plans (see table below).

Local Governments with Geologic Hazard Elements in Land Use Plans and Regulations (DOLA, 2010)					
Type	Number of Municipalities According to Population				Counties
	Pop. Less Than 2000	Pop. 2000 to 5000	Pop. 5000 to 10,000	Pop. Over 10,000	
Land Use Plan	7	3	8	10	12
Regulation	9	8	10	11	39

Following recent disasters, local governments have renewed interest in addressing geologic hazards and CGS receives about 10-20 requests per year from city and county officials to help them create or update natural hazard elements in their land use and emergency management plans. Many of these requests come from smaller communities with limited financial resources but that have significant hazard exposure. CGS assistance typically includes evaluation of hazard vulnerabilities and risks, attending numerous planning and stakeholder meetings (the average plan takes one year to complete), and helping create land use policies.

Before recent staff reductions and increased demands for emergency response, CGS provided technical support to these activities but not to the extent requested or needed by local communities. Over the last several years, CGS has had very limited resources to help local governments create disaster resilient communities.

Lost Opportunities for Geologic Hazard Mapping and Assessments

As noted above, there has been a sharp decrease in CGS geologic hazard mapping and associated technical support to state and local agencies. Local officials cannot protect the built environment, physical infrastructure, the natural environment, and the quality of life in their communities unless they can adequately assess vulnerabilities to geologic hazards.

Comprehensive plans contain the long-term direction of the local community and are the foundation of land use decisions and state and local investment in capital improvements. The purpose of FEMA mandated a Pre-Disaster Mitigation plan is to implement hazard reduction measures prior to a disaster event.

In Colorado, local Pre-Disaster Mitigation and comprehensive plans are typically updated once every five years. Without timely access to geologic hazard assessment and maps, the state and local communities lose the opportunity to build resilience to geologic hazards and protect public safety.

Current CGS Staffing and Key Work Products

Water, Mineral and Energy Activities

Other key statutory mandates call for CGS to promote responsible development of Colorado's vast ground water, mineral and energy resources. CGS produces reports and maps that directly support mineral, mineral fuel, and other industries that produce more than \$12 billion in revenues in the state each year. To support

continuation of these functions, CGS receives approximately \$306,000 in general fund, which partially supports 2.5 FTE.

Geologic Mapping Activities

The CGS primary objective of the geologic mapping program is to establish the geologic framework of areas vital to the economic, social, and scientific welfare of Colorado. Currently, about 160,000 acres are mapped each year. Funding for the program is provided by 50% federal funds and 50% severance tax.

As stated previously, geologic hazard map products are based on thorough geologic mapping and analysis. A hazard map cannot be effectively created without a geologic map. Therefore, geologic mapping resources cannot be directly diverted to mapping of hazards. In addition, federal rules prohibit using federal mapping funds to create derivative maps like geologic hazard maps.

Table Showing Current Staffing and Functions

General Position Title	FTE Equivalent	Primary Job Tasks
State Geologist	1	Administration
Administration	2.5	Publication sales, accounting, purchasing, K-12 outreach and general office support
Hydrogeologist	1.5	Ground water basin studies and projects for state agencies
Hazards Analyst	1	GIS support to hazards mapping and general IT support
Economic Geologist	1	Mineral resource mapping and assessments
Geophysicist	1	Map areas with potential for large-scale geothermal energy and help local governments develop small geothermal energy projects
Mapping Analyst	0.5	GIS support to geologic mapping and ground water programs
Land-Use Review Geologist	2	Review proposed subdivisions for geologic hazards within statutory deadlines
Engineering Geologist	1.5	Rockfall mitigation for CDOT, disaster response, geologic hazard mapping, emergency management planning, hazards public outreach
Geologic Mapping Geologist	2.5	Geologic mapping and public outreach
Total	14.5	

Proposed Solution:

Proposed Solution

The proposed solution is the addition of one FTE and funding of \$105,494 per year and is an ongoing request. The FTE will perform the following tasks:

- Create geologic hazard maps from geologic maps. It is anticipated that as new geologic maps are created each year, the position will take the maps and create new hazard maps. Approximately 160,000 acres would be mapped for geologic hazards each year;
- Provide post disaster response and recovery technical assistance;
- Provide hazard planning technical assistance to state agencies and local governments.

Consequences if the proposed solution is not approved

Consequences include reduced state agency and local community resilience to geologic hazards; including potential economic losses, injuries and deaths. In addition, the ability of the Colorado Geological Survey (CGS) to meet its statutory mission of creating and disseminating geologic hazard to citizens, schools, private sector, and government will be reduced.

Anticipated Outcomes:

If the request is funded:

- Service levels for geologic hazard mapping will return to prior year levels;
- Increase in the ability of CGS to respond to disasters;
- Increase in the ability of CGS to provide timely hazard planning technical assistance to state agencies and local governments;
- Overall outcomes include reduced vulnerability of people, state assets, and property to natural hazards.

Assumptions and Calculations:

FTE, Salary and Associated Costs

See attached FTE calculation worksheet for FTE, salary and associated costs.